DEFENSE ADVANCED RESEARCH PROJECTS AGENCY (DARPA)
11.3 Small Business Innovation Research (SBIR)
Proposal Submission Instructions

DARPA's mission is to prevent technological surprise for the United States and to create technological surprise for its adversaries. The DARPA SBIR and STTR Programs are designed to provide small, high-tech businesses and academic institutions the opportunity to propose radical, innovative, high-risk approaches to address existing and emerging national security threats; thereby supporting DARPA's overall strategy to bridge the gap between fundamental discoveries and the provision of new military capabilities.

The responsibility for implementing DARPA's Small Business Innovation Research (SBIR) Program rests with the Small Business Programs Office.

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY
Attention: DIRO/SBPO
3701 North Fairfax Drive
Arlington, VA 22203-1714
(703) 526-4170
Home Page http://www.darpa.mil/Opportunities/SBIR_STTR/SBIR_STTR.aspx

Offerors responding to the DARPA topics listed in Section 8.0 must follow all the instructions provided in the DoD Program Solicitation. Specific DARPA requirements in addition to or that deviate from the DoD Program Solicitation are provided below and reference the appropriate section of the DoD Solicitation.

SPECIFIC DARPA REQUIREMENTS

Please note – these requirements and guidelines are supplemental to the DoD 11.3 SBIR Program Solicitation. For additional information, please refer to the corresponding section number in the DoD solicitation (http://www.dodsbir.net/solicitation/sbir113/preface113.htm).

2.3 Foreign National

DARPA topics are unclassified; however, the subject matter may be considered to be a "critical technology" and therefore subject to ITAR restrictions. ALL offerors proposing to use foreign nationals MUST follow Section 3.5, b, (7) of the DoD Program Solicitation and disclose this information regardless of whether the topic is subject to ITAR restrictions. See **Export Control** requirements below in Section 5.11.

3.5 Phase I Proposal Format

PHASE I OPTION

DARPA has implemented the use of a Phase I Option that may be exercised to fund interim Phase I activities while a Phase II contract is being negotiated. Only Phase I companies selected for Phase II will be eligible to exercise the Phase I Option. The Phase I Option covers activities over a period of up to four months and should describe appropriate initial Phase II activities that may lead to the successful demonstration of a product or technology. The Phase I Option counts toward the 25-page limit for the Phase I proposal.

A Phase I Cost Proposal ($150,000 maximum) must be submitted in detail online. Proposers that participate in this solicitation must complete the Phase I Cost Proposal, not to exceed the maximum dollar amount of $100,000, and a Phase I Option Cost Proposal, not to exceed the maximum dollar amount of $50,000. Phase I and Phase I Option costs must be shown separately but may be presented side-by-side on a single Cost Proposal. The Cost Proposal DOES NOT count toward the 25-page limit for the Phase I proposal. Phase I awards and options are subject to the availability of funds.

3.7 Phase II Proposals
DARPA Program Managers may invite Phase I performers to submit a Phase II proposal based upon the success of the Phase I contract to meet the technical goals of the topic, as well as the overall merit based upon the criteria in section 4.3 of the DoD Program Solicitation. Phase II proposals will be evaluated in accordance with the evaluation criteria provided in section 4.3. Information regarding Phase II Proposal format will be included in the Phase II Invitation letter.

PHASE II OPTION

DARPA has implemented the use of a Phase II Option that may be exercised at the DARPA Program Manager's discretion to continue funding Phase II activities that will further mature the technology for insertion into a larger DARPA Program or DoD Acquisition Program. The Phase II Option covers activities over a period of up to 24 months and should describe Phase II activities that may lead to the successful demonstration of a product or technology. The Phase II Option counts toward the 40-page limit for the Phase II proposal.

A Phase II Cost Proposal ($1,000,000 maximum) must be submitted in detail online. Proposers that submit a Phase II proposal must complete the Phase II Cost Proposal, not to exceed the maximum dollar amount of $1,000,000, and a Phase II Option Cost Proposal, not to exceed the maximum dollar amount of $750,000. Phase II and Phase II Option costs must be shown separately but may be presented side-by-side on a single Cost Proposal. The Cost Proposal DOES NOT count toward the 40-page limit for the Phase II proposal. Phase II awards and options are subject to the availability of funds.

If selected, the government may elect not to include the option in the negotiated contract.

4.0 Method of Selection and Evaluation Criteria
The offeror's attention is directed to the fact that non-Government advisors to the Government may review and provide support in proposal evaluations during source selection. Non-government advisors may have access to the offeror's proposals, may be utilized to review proposals, and may provide comments and recommendations to the Government's decision makers. These advisors will not establish final assessments of risk and will not rate or rank offeror's proposals. They are also expressly prohibited from competing for DARPA SBIR or STTR awards in the SBIR/STTR topics they review and/or provide comments on to the Government. All advisors are required to comply with procurement integrity laws and are required to sign Non-Disclosure and Rules of Conduct/Conflict of Interest statements. Non-Government technical consultants/experts will not have access to proposals that are labeled by their proposers as "Government Only."

Please note that qualified advocacy letters will count towards the proposal page limit and will be evaluated towards criterion C. Advocacy letters are not required for Phase I or Phase II. Consistent with Section 3-209 of DoD 5500.7-R, Joint Ethics Regulation, which as a general rule prohibits endorsement and preferential treatment of a non-federal entity, product, service or enterprise by DoD or DoD employees in their official capacities, letters from government personnel will NOT be considered during the evaluation process.

A qualified advocacy letter is from a relevant commercial procuring organization(s) working with a DoD or other Federal entity, articulating their pull for the technology (i.e., what need the technology supports and why it is important to fund it), and possible commitment to provide additional funding and/or insert the technology in their acquisition/sustainment program. If submitted, the letter should be included as the last page of your technical upload. Advocacy letters which are faxed or e-mailed separately will NOT be considered.

4.2 Evaluation Criteria

In Phase I, DARPA will select proposals for funding based on the evaluation criteria contained in Section 4.2 of the DoD Program Solicitation, including potential benefit to DARPA, in assessing and selecting for award those proposals offering the best value to the Government.

In Phase II, DARPA will select proposals for funding based on the evaluation criteria contained in Section 4.3 of the Program Solicitation, including potential benefit to DARPA and ability to transition the technology into an identified system, in assessing and selecting for award those proposals offering the best value to the Government.

As funding is limited, DARPA reserves the right to select and fund only those proposals considered to be of superior quality and highly relevant to the DARPA mission. As a result, DARPA may fund more than one proposal in a specific topic area if the quality of the proposals is deemed superior and are highly relevant to the DARPA mission, or it may not fund any proposals in a topic area. Each proposal submitted to DARPA must have a topic number and must be responsive to only one topic.

4.4 Assessing Commercial Potential of Proposals

DARPA is particularly interested in the potential transition of SBIR project results to the U.S. military, and expects explicit discussion of a transition vision in the commercialization strategy part of the proposal. That vision should include identification of the problem, need, or requirement in the Department of Defense that the SBIR project results would address; a description of how wide-spread and significant the problem, need, or requirement is; identification of the potential end-users (Army, Navy, Air Force, SOCOM, etc.) who would likely use the technology; and the operational environments and potential application area(s).

Technology commercialization and transition from Research and Development activities to fielded systems within the DoD is challenging. Phase I is the time to plan for and begin transition specific activities. The small business must convey an understanding of the transition path or paths to be established during the Phase I and II projects. That plan should include the Technology Readiness Level (TRL) at the start and end of the Phase II. The plan should also include a description of targeted operational environments and priority application areas for initial Phase III transition; potential Phase III transition funding sources; anticipated business model and identified commercial and federal partners the SBIR company has identified to support transition activities. Also include key proposed milestones anticipated during Phase I, II or beyond Phase II that include, but are not limited to: prototype development, laboratory and systems testing, integration, testing in operational environment, and demonstrations.

4.5 SBIR Fast Track

Small businesses that participate in the Fast Track program do not require an invitation to submit a proposal, but must submit an application. The complete Fast Track application must be received by DARPA no later than the last day of the fifth month of the Phase I effort. Once your application is submitted, the DARPA Program Manager will make a determination on whether or not a technical proposal will be accepted for the Phase II effort. If the DARPA Program Manager approves the Fast Track application, the small business will have 30 days to submit the technical proposal.

Any Fast Track applications not meeting these dates may be declined. All Fast Track applications and required information must have a complete electronic submission. The DoD proposal submission site will lead you through the process for submitting your technical proposal and all of the sections electronically.

Firms who wish to submit a Fast Track Application to DARPA must utilize the DARPA Fast Track application template. Failure to follow these instructions may result in automatic rejection of your application. Phase I interim funding is not guaranteed. If awarded, it is expected that interim funding will generally not exceed $50,000. Selection and award of a Fast Track proposal is not mandated and DARPA retains the discretion not to select or fund any Fast Track applicants. NOTE: Phase I firms whose proposals are not accepted for a Fast Track Phase II award are not eligible to receive a Phase II invitation from the agency.

- DARPA encourages Phase I performers to discuss its intention to pursue Fast Track with the DARPA Program Manager prior to submitting a Fast Track application or proposal.
- Fast Track awards are subject to the availability of funds.
- After coordination with the DARPA Program Manager, the performer and the investor should submit a Fast Track application through the DoD Submission Web site no later than the last day of the fifth month of the Phase I effort.
- The Fast Track Interim amount is not to exceed $50,000.
- Additional information regarding the DARPA Fast Track process and application template may be found at: http://www.darpa.mil/Opportunities/SBIR_STTR/SBIR.aspx

4.6 Phase II Enhancement Policy

To encourage transition of SBIR projects into DoD systems, DARPA's Phase II Enhancement Program provides a Phase II performer up to $200,000 of additional Phase II SBIR funding if the performer can match the additional SBIR funds with funds from a DoD acquisition program, a non-SBIR/non-STTR government program or private sector investments. The Phase II Enhancement Program allows for an existing Phase II SBIR to be extended for up to one year per Phase II Enhancement application, to perform additional research and development and further mature the technology. Phase II Transition matching funds will be provided on a one-for-one basis up to a maximum amount of $200,000 of SBIR or funds in accordance with DARPA Phase II Enhancement policy.

Phase II Enhancement funding can only be applied to an active DoD Phase II SBIR contract. The funds provided by the DoD acquisition program or a non-SBIR/non-STTR government program may be obligated on the Phase II contract as a modification prior to or concurrent with the modification adding DARPA SBIR funds, OR may be obligated under a separate contract. Private sector funds must be from an "outside investor" which may include such entities as another company, or an investor. It does not include the owners or family members, or affiliates of the small business (13 CFR 121.103).

4.7 Commercialization Pilot Program

DARPA has established a Transition Support Pilot Program with the objective to increase transition success for companies that have one or multiple active DARPA-funded SBIR and/or STTR Phase II projects. This is accomplished through the identification of viable Phase III funding sources, and potential government and commercial partners interested in collaborating with the companies to further mature the technology to ***Technology Readiness Level (TRL) 7: System prototype demonstration in an operational environment.*** Achievement of this milestone takes the technology beyond the initial demonstration phase, typically the maximum achieved in Phase II, and is a key step in a transition roadmap for the testing and fielding of new capabilities to the U.S. military and other federal agencies with similar requirements.

Approach
The Foundation for Enterprise Development (The Foundation), a U.S.-owned non-profit organization, is assisting the DARPA Program Director, Small Business Programs Office in implementing the Pilot.

- **Transition Assistance:** The Foundation will provide companies that have one or multiple active DARPA-funded SBIR and/or STTR Phase II projects that elect to participate in the Pilot with assistance in preparing a transition plan as well as provide targeted assistance in identifying potential Phase III funding sources, and potential government and commercial partners with requirements for the technology under development. The Foundation will also provide suggestions on the development of project materials and facilitate introductions to the potential funding sources and partners. DARPA Phase II SBIR and STTR projects in the Pilot program will be included in a transition/commercialization report prepared annually by DARPA.

- **Success Reports:** The Foundation will document company transition successes in a brochure or other printed material for distribution at outreach events. The DARPA Success Reports can be viewed at this link:
http://www.darpa.mil/Opportunities/SBIR_STTR/SBIR_STTR_Success_Reports.aspx

- **Outreach/Process Improvement:** The Foundation will capture lessons learned, best practices and help develop and implement process improvements to increase transition success for DARPA-funded SBIR and STTR companies. We welcome feedback from the participating companies and the DARPA program managers during the Pilot.

- **Company Participation Process:** Companies that elect to participate in the Pilot program will be asked to sign a technology transition support agreement (TTA) that specifies what activities will be performed by the Foundation and the SBIR or STTR company's obligations and other provisions. Once the agreement is signed, transition support will begin.

5.1.b. Type of Funding Agreement (Phase I)
- DARPA Phase I awards will be Firm Fixed Price contracts.
- Companies that choose to collaborate with a University must highlight the research that is being performed by the University and verify that the work is FUNDAMENTAL RESEARCH.
- Companies are strongly encouraged to pursue implementing a government acceptable cost accounting system during the Phase I project to avoid delay in receiving a Phase II award. Visit www.dcaa.mil and download the "Information for Contractors" guide for more information.

5.1.c. Average Dollar Value of Awards (Phase I)
DARPA Phase I proposals **shall not exceed $150,000,** and are generally six months in duration.

5.2.b. Type of Funding Agreement (Phase II)
- DARPA Phase II awards are typically Cost-Plus-Fixed-Fee contracts; however, DARPA may choose to award a Firm Fixed Price Phase II contract or an Other Transaction (OT) on a case-by-case basis. Visit:
http://www.darpa.mil/Opportunities/SBIR_STTR/Small_Business_OTs.aspx for more information on Other Transactions.
- Companies are advised to continue pursuit of implementation of a government acceptable cost accounting system in order to facilitate their eligibility for future government contracts.

- Companies that choose to collaborate with a university must highlight the research that is being performed by the university and verify that the work is FUNDAMENTAL RESEARCH.

5.2.c. Average Dollar Value of Awards (Phase II)
DARPA Phase II proposals should be structured as a 24 month effort in two equal increments of approximately $500,000 each. The entire Phase II base effort should generally not exceed $1,000,000.

5.3 Phase I Report
All DARPA Phase I and Phase II awardees are required to submit a final report, which is due within 60 days following completion of the technical period of performance and must be provided to the individuals identified in Exhibit A of the contract. Please contact your contracting officer immediately if your final report may be delayed.

5.11.r. Export Control
The following will apply to all projects with military or dual-use applications that develop beyond fundamental research (basic and applied research ordinarily published and shared broadly within the scientific community):

(1) The Contractor shall comply with all U. S. export control laws and regulations, including the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 through 130, and the Export Administration Regulations (EAR), 15 CFR Parts 730 through 799, in the performance of this contract. In the absence of available license exemptions/exceptions, the Contractor shall be responsible for obtaining the appropriate licenses or other approvals, if required, for exports of (including deemed exports) hardware, technical data, and software, or for the provision of technical assistance.

(2) The Contractor shall be responsible for obtaining export licenses, if required, before utilizing foreign persons in the performance of this contract, including instances where the work is to be performed on-site at any Government installation (whether in or outside the United States), where the foreign person will have access to export-controlled technologies, including technical data or software.

(3) The Contractor shall be responsible for all regulatory record keeping requirements associated with the use of licenses and license exemptions/exceptions.

(4) The Contractor shall be responsible for ensuring that the provisions of this clause apply to its subcontractors.

Please visit http://www.pmddtc.state.gov/regulations_laws/itar.html for more detailed information regarding ITAR requirements.

5.11.s. Publication Approval (Public Release)
NSDD 189 established the national policy for controlling the flow of scientific, technical, and engineering information produced in federally funded fundamental research at colleges, universities, and laboratories. The directive defines fundamental research as follows: 'Fundamental research' means basic and applied research in science and engineering, the results of which ordinarily are published and shared broadly within the scientific community, as distinguished from proprietary research and from industrial development, design, production, and product utilization, the results of which ordinarily are restricted for proprietary or national security reasons."

It is DARPA's goal to eliminate pre-publication review and other restrictions on fundamental research except in those exceptional cases when it is in the best interest of national security. Please visit http://www.darpa.mil/NewsEvents/Public_Release_Center/Public_Release_Center.aspx for additional information and applicable publication approval procedures. Visit http://dtsn.darpa.mil/fundamentalresearch/ to verify whether or not your award has a pre-publication review requirement.

5.14.h. Human and/or Animal Use

This solicitation may contain topics that have been identified by the program manager as research involving Human and/or Animal Use. In accordance with DoD policy, human and/or animal subjects in research conducted or supported by DARPA shall be protected. Although these protocols will most likely not be needed to carry out the Phase I, significant lead time is required to prepare the documentation and obtain approval in order to avoid delay of the Phase II award. Please visit http://www.darpa.mil/Opportunities/SBIR_STTR/SBIR.aspx to review the Human and Animal Use PowerPoint presentation(s) to understand what is required to comply with human and/or animal protocols.

- **Human Use:** All research involving human subjects, to include use of human biological specimens and human data, selected for funding must comply with the federal regulations for human subject protection. Further, research involving human subjects that is conducted or supported by the DoD must comply with 32 CFR 219, *Protection of Human Subjects* http://www.access.gpo.gov/nara/cfr/waisidx_07/32cfr219_07.html) and DoD Directive 3216.02, *Protection of Human Subjects and Adherence to Ethical Standards in DoD-Supported Research* (http://www.dtic.mil/whs/directives/corres/pdf/321602p.pdf).

  Institutions awarded funding for research involving human subjects must provide documentation of a current Assurance of Compliance with Federal regulations for human subject protection, for example a Department of Health and Human Services, Office of Human Research Protection Federal Wide Assurance (http://www.hhs.gov/ohrp). All institutions engaged in human subject research, to include subcontractors, must also have a valid Assurance. In addition, personnel involved in human subjects research must provide documentation of completing appropriate training for the protection of human subjects.

  For all proposed research that will involve human subjects in the first year or phase of the project, the institution must provide evidence of or a plan for review by an Institutional Review Board (IRB) upon final proposal submission to DARPA. The IRB conducting the review must be the IRB identified on the institution's Assurance. The protocol, separate from the proposal, must include a detailed description of the research plan, study population, risks and benefits of study participation, recruitment and consent process, data collection, and data analysis. Consult the designated IRB for guidance on writing the protocol. The informed consent document must comply with federal regulations (32 CFR 219.116). A valid Assurance along with evidence of appropriate training for all investigators should accompany the protocol for review by the IRB.

  In addition to a local IRB approval, a headquarters-level human subjects regulatory review and approval is required for all research conducted or supported by the DoD. The Army, Navy, or Air Force office responsible for managing the award can provide guidance and information about their component's headquarters-level review process. Note that confirmation of a current Assurance and appropriate human subjects protection training is required before headquarters-level approval can be issued.

The amount of time required to complete the IRB review/approval process may vary depending on the complexity of the research and/or the level of risk to study participants. Ample time should be allotted to complete the approval process. The IRB approval process can last between one to three months, followed by a DoD review that could last between three to six months. No DoD/DARPA funding can be used towards human subjects research until ALL approvals are granted.

- **Animal Use:** Any Recipient performing research, experimentation, or testing involving the use of animals shall comply with the rules on animal acquisition, transport, care, handling, and use in: (i) 9 CFR parts 1-4, Department of Agriculture rules that implement the Laboratory Animal Welfare Act of 1966, as amended, (7 U.S.C. 2131-2159); (ii) the guidelines described in National Institutes of Health Publication No. 86-23, "Guide for the Care and Use of Laboratory Animals"; (iii) DoD Directive 3216.01, "Use of Laboratory Animals in DoD Program."

  For submissions containing animal use, proposals should briefly describe plans for Institutional Animal Care and Use Committee (IACUC) review and approval. Animal studies in the program will be expected to comply with the PHS Policy on Humane Care and Use of Laboratory Animals, available at http://grants.nih.gov/grants/olaw/olaw.htm.

  All Recipients must receive approval by a DoD certified veterinarian, in addition to an IACUC approval. No animal studies may be conducted using DoD/DARPA funding until the USAMRMC Animal Care and Use Review Office (ACURO) or other appropriate DoD veterinary office(s) grant approval. As a part of this secondary review process, the Recipient will be required to complete and submit an ACURO Animal Use Appendix, which may be found at https://mrmc-www.army.mil/index.cfm?pageid=Research_Protections.acuro&rn=1.

6.3 Notification of Proposal Receipt

After the solicitation closing date, DARPA will send an e-mail to the person listed as the "Corporate Official" on the Proposal Coversheet acknowledging receipt of proposal.

6.4 Information on Proposal Status

Once the source selection is complete, DARPA will send an email to the person listed as the "Corporate Official" on the Proposal Coversheet with instructions for retrieving letters of selection or non-selection from the DARPA SBIR/STTR Information Portal.

6.5 Debriefing of Unsuccessful Offerors

DARPA will provide debriefings to offerors in accordance with FAR Subpart 15.5. The notification letter referenced above in paragraph 6.4 will provide instructions for requesting a proposal debriefing. Small Businesses will receive a notification for each proposal submitted. Please read each notification carefully and note the proposal number and topic number referenced. All communication from the DARPA SBIR/STTR Program management will originate from the sbir@darpa.mil e-mail address. Please white-list this address in your company's spam filters to ensure timely receipt of communications from our office.

DARPA SBIR 11.3 Topic Index

DARPA SBIR 11.3 Topic Descriptions

SB113-001 TITLE: Lightweight Public Key Algorithms (PKA) for Low Power Environments

TECHNOLOGY AREAS: Information Systems, Sensors

OBJECTIVE: Identify and develop potential new Public Key Algorithms (PKAs) that can be implemented in low size, weight and power (SWAP) environments. Demonstrate their efficacy in providing low latency communications in dynamically configurable networks. Quantify performance of proposed algorithms with respect to figures of interest such as network size, desired throughput, etc.

DESCRIPTION: The reliance on networks of all kinds is pervasive throughout the Department of Defense (DoD). Of particular and growing importance is the use of networks of distributed, low size, weight and power (SWAP) sensors of limited range that can, by acting cooperatively, provide widearea capability. The informative power of this capability is often directly dependent on the relative quality of communications, both intraand internetwork, that are available to the constituent nodes. Consequently, communication capacity emerges as a vital component of the networked system, and thus its integrity must be ensured. Encryption is typically employed to ensure communication security, but many cryptographic techniques rely on static configurations (e.g., the ability to ensure secure key distribution) to achieve the desired level of protection. Conversely, public key algorithms (PKAs) can be used in dynamic settings. However, standard implementations such as RSA or those based on discretelogarithms are computationally intensive and have not been designed for use in low SWAP environments.

DARPA is interested in research and development into new classes of PKAs that are particularly well suited for low SWAP network settings. Investigations should include quantitative analysis of the relative strength of any proposed algorithm, as well as characterization of its complexity (both in space and time) and its scalability.

PHASE I: Investigate and identify potential new PKAs. A detailed mathematical analysis of strengths and weaknesses must be provided. Quantify computational complexity, both in space and time, and determine scalability (in terms of network size) of any proposed approach. While this analysis may be supported by simulation, rigorous derivation of all claims is to be preferred. Phase I deliverables should also include a preliminary conceptual design of a network of generic low SWAP sensors on which the proposed PKAs are hosted.

PHASE II: Further develop, demonstrate and validate the efficacy of the PKAs proposed in Phase I. Early proof-of-concept demonstrations should take the form of software simulations that verify the complexity and scalability claims derived earlier in the effort. Later phase effort should be directed toward the construction of a hardware based demonstration comprising networks of low SWAP nodes. For both demonstrations, developers will be responsible for formulating meaningful performance metrics, and constructing a relevant test plan based on these. In addition, it is highly desirable that late phase demonstrations are motivated by realworld applications, and resources should be devoted to ensuring that proposed architectures align with current and future DoD relevant scenarios.

PHASE III: In the commercial realm, this work has the potential for use in mobile ad hoc networks (MANETs), and hence will be of interest to a wide range of telecommunications providers. Because of prevalence of networks and networked sensors throughout the DoD, the research to be undertaken in this effort is of potential value in many military applications. One potential customer is USMC, which makes use of distributed sensors in providing force protection to its expeditionary forces.

REFERENCES:

1. Kaufman, C., Perlman, R., Speciner, M, Network Security: Private Communication in a Public World, Second Edition, Prentice Hall, 2002

2. Stallings, W., Cryptography and Network Security: Principles and Practice, Third Edition, Prentice Hall, 2003

KEYWORDS: Communication security, Encryption, Public Key Algorithms, Distributed Sensing

SB113-002 TITLE: Wafer-level Short Wave Infrared (SWIR) Micro-Camera

TECHNOLOGY AREAS: Materials/Processes, Sensors

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop manufacturing approaches and sensor configurations for short wave infrared (SWIR) focal plane arrays (FPAs) that significantly reduce the cost of SWIR FPA packaging, optics and integration into micro-systems.

DESCRIPTION: SWIR imaging technology has significant advantages over conventional low light level imaging approaches, providing increased sensitivity and capturing unique target characteristics associated with the SWIR spectral band. SWIR FPAs are sensitive from the visible to short wave infrared with spectral band cutoff at 1.7um, where there is a large ambient signal level due to "night glow." In addition to sensitivity advantages, SWIR imaging adds the capability for covert illumination outside the spectral range of conventional low light level devices; the capability to detect hidden and camouflaged targets; and sensitivity to battlefield lasers and target designators.

Widespread military application of these significant system performance advantages requires high quality SWIR FPAs affordable for general use in military systems. Recent improvements in SWIR detector and FPA technology have led to sensors with considerable system advantages. The dark current of shortwave sensitive material, indium gallium arsenide, has been substantially reduced, enhancing the signal-to-noise and increasing the operating temperature, ultimately with the potential for room temperature operation. Likewise, the noise of the readout integrated circuit has been reduced without sacrifice of dynamic range.

Transition of these substantial performance improvements into affordable systems will establish digital low light level imaging for military systems. Successful transition of SWIR FPAs can be facilitated by a substantial reduction in the cost of SWIR imaging sensors. New sensor configurations and innovative system designs are needed to capitalize on the recent advances in material and device technology and establish an affordable SWIR camera technology. In current manufacturing approaches, SWIR FPAs are individual packaged and integrated with optics. A wafer scale approach for die packaging and optics integration would significantly reduce sensor cost. New sensor concepts are also needed to achieve large format arrays, providing large field of view, with high resolution focused on critical areas of interest in the scene. These design innovations and low cost manufacturing approaches could also lead to micro-cameras with significant reduction in camera size and open new applications in helmet mounted systems and sensors for micro-air and ground vehicles.

PHASE I: Investigate packaging and optics integration for short wave infrared focal plane arrays to include assessment of materials and manufacturing approaches amendable to the manufacture of wafer level camera; Determine optimum array format and pixel size for imaging at a target identification range of 100 to 1,000 meters with minimum of horizontal field of view of forty (40) degrees; Assess the potential to produce a large format SWIR imager with size less than 20 cm3. Perform thermal, mechanical, optical analysis of encapsulation and optical materials to assess compatibility with SWIR FPA manufacturing.

PHASE II: Demonstrate with a small format SWIR array the design developed in Phase I, leading toward a wide field of view SWIR camera. The design shall demonstrate the potential for 10X cost reduction relative to current camera cost, and the potential for the overall volume reduction.

PHASE III: SWIR cameras currently have military and commercial applications, both benefiting from the cost and size reduction associated with wafer level focal plane arrays. Commercial applications include homeland security, industrial process control, and biomedical applications. Military applications are focused on night imaging for a wide range of areas, including both man-portable systems and micro air and ground vehicles. The contractor shall fabricate the wide field o f view SWIR camera and show volume and size reduction relative to state of the art SWIR cameras. The camera shall demonstrate imaging over a minimum forty (40) degree horizontal field of view with

target identification range for tactical applications. The contractor shall demonstrate the potential for 10X cost camera cost reduction, while maintaining performance for man-portable applications, such as helmet mounted and rifle sight applications.

REFERENCES:
1. Enriquez, Marlon D. et al, "Performance of High Resolution Visible InGaAs Imager for Day/Night Vision", Proc. of SPIE Vol. 6940 (2008), Infrared Technology and Applications XXXIV.

2. Hoelter, Theodore R. and Barton, Jeffrey B., "Extended Short Wavelength Response from InGaAs Focal Plane Arrays", Proc. of SPIE Vol. 5074 (2003), Infrared Technology and Applications XXIX.

3. Zoberbier, Margarete et al,"Wafer Level Cameras Novel Fabrication and Packaging Technologies", International Image Sensor Workshop, Bergen, Norway 2009, Image Sensor Fabrication and Packaging.

KEYWORDS: SWIR, Manufacturing, Packaging, Lowcost, SWIR optics, electronics, 3D integration

SB113-003 TITLE: Silicon based Millimeter-Wave (MMW) sparse array radiometer receiver for photonic processing

TECHNOLOGY AREAS: Sensors, Electronics

ACQUISITION PROGRAM: DARPA Multifunction RF

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Demonstrate a single chip silicon based circuit forming the receiver of a MMW sparse array radiometer with an output suitable for photonic processing.

DESCRIPTION: Passive millimeter wave technology has been investigated for over five decades as a sensing modality with unique properties that may prove useful for military and commercial applications. Recent applications have ranged from screening personnel for contraband at military checkpoints and commercial distribution centers to providing video rate imaging for combat helicopters to land in degraded visual conditions such as dust, snow, and fog. Work from the 90's up to the current time has been ongoing to demonstrate the utility of using photonics for processing the down converted (not detected) output from MMW receivers in such a manner that video cameras are used to transform images into video data streams [1]. A challenge to practically realizing such a system has been the inability to achieve sufficient sensitivity with purely photonic receivers and maintain inter-channel balance and single receiver stability in an affordable manner [2]. With recent advances in SiGe RF circuits [3], we may have reached a point where all of these issues can be addressed in a single silicon based circuit.

PHASE I: Design the architecture of a single chip silicon based circuit forming the receiver of a MMW sparse array radiometer with an output suitable for photonic processing. Establish the potential processes ensuring the receiver is stable and calibrated, how it will achieve sufficient sensitivity to be useful in a passive MMW system, and how it will interface with a photonics processor suitable for processing sparse aperture imagery.

PHASE II: Based on the Phase I results, design and fabricate a silicon based circuit and demonstrate capability to operate with a photonics image processor. Sufficiently demonstrate the stability of the circuit, the variations in performance from chip to chip, and the ability to interface the chip to a photonics processor. Include antennas required for matching the circuit to the scene to be imaged.

PHASE III: Under Phase III it is expected that the performer will transition the design of the circuit developed into a system suitable for use in pilotage and navigation under degraded visual environments or in to security screening imagers used for contraband detection and security screening imagers used for military checkpoints.

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[3] Tomkins et al, "A Passive WBand Imaging Receiver in 65 nm Bulk CMOS," IEEE Journal of Solid State Circuits, Vol. 45, No. 10, October 2010.

KEYWORDS: Millimeter wave, radiometer sparse array, photonics, LNA, silicon

SB113-004 TITLE: Advanced Propellants Capable of Controllable and Regulated Burns

TECHNOLOGY AREAS: Materials/Processes, Weapons

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Identify and develop advanced, high efficiency propellants and/or divert actuator and attitude control systems exhibiting highly controllable and steady burn properties for endo-atmospheric and exo-atmospheric use. The system shall be operational at ambient temperatures from -60 deg F to 170 deg F. Fast reaction times for the propellant systems are desired with a goal of less than 10 ms. The goal is also to produce a green propellant that meets insensitive munitions requirements. Novel concepts for propellant systems that have a high system mass fraction (greater than 40%) and a high delta velocity (greater than 1000 m/s) are desired.

DESCRIPTION: Current US Navy missile systems can be made more capable with controllable, high efficiency divert actuator control systems and attitude control systems with innovative designs and novel propellants. Unsteady burn properties can result in high rates of jitter or vibrational noise, which can affect missile performance in target acquisition, track, and the required precision in missile orientation. Future missile systems will probably require the kill vehicle to travel longer distances and achieve higher divert margins than their predecessors. To achieve future requirements the divert actuator control systems and the attitude control systems will require more efficient designs and higher energy density. Systems that can regulate the burn rate to conserve fuel are of interest. Increased efficiency may reduce kill vehicle weight which would allow move velocity from the main propulsion system to achieve faster target intercepts and improve the opportunities to engage the target. Increased fuel efficiency is also desired to achieve the longer range, larger divert requirements as well as maintain or reduce the current weight and/or volume of propellant used within the missile. In addition, US Navy missile requirements aim to use propellant materials and missile designs that facilitate the release of explosive energy without violent reaction or fratricide of adjacent munitions. This requirement has significantly limited the implementation of proposed hypergolic liquid propellant designs. Hypergolic liquid propellants' inherent toxicity is a cause of concern for current US Navy missile applications.

This topic is soliciting innovative propellant materials of any state (solid, liquid or other) and system designs for innovative divert actuator control systems and attitude control systems, and includes evaluating thrust diverter actuator systems for new and innovative methods to achieve a higher level of missile kill vehicle performance and enhancing system predictability.

PHASE I: Develop a concept for an innovative propellant system and/or new propellant material that meets the objective listed above. In addition, create a plan of approach, or roadmap, to develop, test and demonstrate the proposed technology. Phase I deliverables will include a technical report and brief describing the technical feasibility and merit of the use of advanced propellants and/or innovative propellant system. The deliverables shall also include the plan of approach.

PHASE II: Develop the concepts investigated in Phase I. Develop, test and demonstrate concept feasibility in a missile environment. In addition, deliverables will include a report and brief describing the technical merit of the use of advanced propellants and the propellant system design approach and the feasibility of use in future Navy missile programs.

PHASE III: Finalize the design and manufacture of high efficiency propellants and propellant actuator systems exhibiting highly controllable and steady burn properties while facilitating the release of explosive energy without violent reaction. Possible applications may include, but are not limited to the following:
• Commercial Applications: Spacecraft, Satellites, Rockets, Unmanned vehicles
• DoD/Military Applications: Missiles - Strike, Ballistic Missile Defense (Phased Adaptive Approach), Land Based, Sea Based (surface launched, submarine launched, air launched)

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KEYWORDS: Propellant, Actuator, Chemistry